



Site Characterization

In its 2000 session, the Wyoming Legislature created new opportunities, procedures, and standards for voluntary remediation of contaminated sites. These provisions, enacted as Articles 16, 17, and 18 of the Wyoming Environmental Quality Act and implemented by the Wyoming Department of Environmental Quality, will govern future environmental cleanups in Wyoming.

This Fact Sheet provides information about site characterization under the Voluntary Remediation Program.

1. What is a site?

A site is a parcel of real property that is being addressed under the Voluntary Remediation Program (VRP). A wide range of types of sites may be addressed under the VRP, from relatively small, simple cleanups of a single contaminant in a single environmental medium to very large, technically complex sites where cleanup is needed for many contaminants and more than one environmental medium. Volunteers may enter the VRP for an entire piece of property or facility, a specific portion of a piece of property or facility, or a specific release. The property or facility (or portion of a property or a facility) that is in the VRP is referred to as a “site.” Because a wide range of sites will be addressed under the VRP, the Department of Environmental Quality (DEQ) has designed the guidance provided in this and other VRP Fact Sheets to be flexible, so that site-specific VRP activities and requirements can be tailored appropriately to the site in question.

In addition, DEQ has identified two specific types of sites that warrant special attention and procedures under the VRP. The first is sites where contamination is limited to soil and the remedial approach is excavation of all soil with contamination above cleanup levels for unrestricted site uses. Volunteers may choose to cleanup these sites using streamlined administrative procedures -- called the independent cleanup process (ICP). For more information on this procedure, see Fact Sheet #6 *Independent Cleanup*.

The second type of site to warrant special attention and procedures is a spill response site during the immediate phase of spill response. The VRP does not replace the current requirements and procedures for spill response. If you have experienced a reportable spill or release, you should contact DEQ immediately at (307) 777-7781. For more information on spill response sites, see Fact Sheet #5 *Spill Response*.

2. What is site characterization and why is it needed?

Site characterization refers to a set of site-specific activities that are designed and carried out to identify and understand contaminants and contaminant sources that are or might be present at a site. Site characterization is needed to support remediation decisions. Without adequate information about a site, decisions about appropriate remedial actions needed to protect human health and the environment cannot be made. All sites in the VRP will require site characterization.

During site characterization, Volunteers identify and gather information about the site necessary to develop a site conceptual model capable of supporting selection and implementation of remedial actions. Typical site characterization activities include evaluations of the historical uses of property, site reconnaissance, and collection and analysis of environmental samples. DEQ has chosen to encourage “biased” site characterization. This means that Volunteers are encouraged to determine sampling locations, analytes and other characterization activities by using information already known about a site to identify the most likely locations and sources of contamination and the most likely contaminants. Biased site characterization is standard in cleanup programs.

In a few circumstances, grid sampling outside known or suspected areas of contamination may be needed to complement biased sampling. For example, DEQ anticipates that grid sampling will be needed when a volunteer has requested a no further action letter liability assurance (as opposed to a certificate of completion liability assurance). This issue is discussed further in question 10 in this Fact Sheet.

3. How will DEQ evaluate the adequacy of site characterization?

DEQ will evaluate the adequacy of site characterization using the site characterization performance criteria and good engineering and geological practices.

In order to develop a conceptual model of the site and the risks and potential risks posed by the site that is adequate and appropriate to support selection and implementation of a permanent or long-term protective remedy that meets the VRP cleanup standards established in §W.S. 35-11-1605(a) for the site and other affected property, site characterization should describe:

- The site and site setting.
- Known and potential sources of contamination.
- The nature and distribution of contaminants, and media properties that is likely to influence contaminant distribution or the ability to implement remedial alternatives.
- Human and ecological receptors.

The site characterization performance criteria are drawn from the requirements for preliminary remediation agreements in §35-11-1606 and the VRP cleanup standards in §35-11-1605(a).

According to §35-11-1605(a), remedies approved under the VRP must:

- Protect human health, safety and the environment.
- Remediate contaminated air, soil and water to attain applicable cleanup levels established under federal or state law or regulation, or to attain site-specific risk-based cleanup levels developed for the site in question.
- Control sources of releases to reduce or eliminate, to the extent technically practicable, further releases as required protecting human health and the environment.
- Comply with applicable standards for management of waste generated as a consequence of the remedy.

For most sites, site characterization activities will be negotiated between DEQ and the Volunteer when they negotiate a preliminary remediation agreement (PRA). According to §35-11-1606, in general, preliminary remediation agreements approved under the VRP must include:

- The information and procedures required for completion of an environmental assessment or site characterization that is adequate and appropriate to support selection of a remedy that meets VRP cleanup standards.
- A work plan, schedule, and statement of any criteria DEQ intends to use to evaluate work plans and reports.
- For sites with the potential for significant contamination, or that meet other criteria as outlined in §35-11-1606(b), a description of alternative remedial actions to be evaluated (see §35-11-1606(b)).

4. Will DEQ use anything else to evaluate the adequacy of site characterization?

In addition to the site characterization performance criteria, a number of principles guide DEQ's approach to site characterization. These principles are:

- Adequate and appropriate site characterization is critical to all cleanups and necessary to support selection and implementation of remedial actions.
- Site characterization is not an end unto itself; its purpose is to gather information necessary to make cleanup decisions.
- Site characterization activities should be commensurate with the complexity of the site and/or release in question.

These principles are very important because they will help DEQ and Volunteers develop site-specific site characterization approaches that are both effective and efficient.

5. What are contaminants?

Under §35-11-103(g)(iii), a contaminant is defined as any chemical, material, substance, or waste that is regulated under any applicable federal, state or local law or regulation, that is classified as hazardous or toxic under federal, state or local law or regulation, or to which exposure is regulated under federal, state or local law or regulation.

6. What types of information do I have to collect during site characterization?

During site characterization, Volunteers will gather information necessary to meet the site characterization performance criteria (i.e., to develop a site conceptual model that will support identification and implementation of a site-specific remedy that meets VRP cleanup standards as discussed in question 3). The exact information necessary will depend on site-specific circumstances. However, at most sites, DEQ believes meeting the site characterization performance criteria will include some level of description and analysis of the following:

- The site and site setting, including information such as the site name and location, legal description, site and adjacent property ownership, historical site uses and known contamination.
- Known and potential sources of contamination, including information such as descriptions of tanks, solid waste management units, disposal areas and releases, and remedial activities carried out to date.
- The nature and distribution of contaminants and media properties that is likely to influence contaminant distribution or the ability to implement remedial alternatives, including information on soil and bedrock, groundwater, surface water and air.
- Human and ecological receptors, including information such as number of people who work at or near the site and sensitive populations present at or near the site. In addition, a simple Ecological Exclusion Assessment checklist (see Fact Sheet #14, *Ecological Risk Assessment*) must be submitted. The Ecological Exclusion Assessment checklist is designed to identify sites where ecological receptors are unlikely to be affected.

Again, the level of description and analysis necessary, and exact site characterization activities needed, will depend on site-specific circumstances. To assist Volunteers in developing site-specific site characterization activities, DEQ has prepared detailed guidelines on the types of information that might be needed during site characterization. These guidelines are attached to this Fact Sheet. DEQ cannot overemphasize, however, that in planning and implementing site characterization, Volunteers and the public must understand that every site is different and the exact activities needed for adequate site characterization at any given site will depend on site-specific conditions. Some sites present a relatively uncomplicated set of environmental and contaminant conditions, so all the information necessary to support selection and implementation of an appropriate remedial action can be gathered easily. Other sites present a more complicated set of environmental and contaminant conditions, or will be remediated using a remedy that requires additional site

information, such as monitored natural attenuation. At these types of sites, more detailed information will be needed to support selection and implementation of appropriate remedial actions.

DEQ's guidelines for the types of information that might be needed during site characterization are intended as a starting point for a site-specific evaluation of the types of information that are actually needed to meet the site characterization performance criteria. At some sites, only a small subset of the information listed in the guidelines might be needed; at other sites, all of the information listed in the site characterization guidelines might be needed, or information that is not listed in the guidelines might be needed.

7. What is a site conceptual model and why is it needed?

A site conceptual model is a description of the surface and subsurface of a site and the site environmental setting, including contaminant sources, release mechanisms, migration routes, potential human and ecological receptors, and exposure pathways. It is used in planning and implementing site characterization and other remedial activities.

Development of a site conceptual model, like site characterization itself, is an iterative process where available information supports and refines priorities for collection and analysis of additional information, until all information necessary to meet the site characterization performance criteria has been gathered. You should create your site conceptual model at the beginning of site characterization activities using known information about the site and then update it to include new information as site characterization moves forward. Site conceptual models will improve site characterization processes by providing a common framework from which Volunteers, DEQ, and the public can understand and discuss site information. They also will organize site information in a way that highlights data gaps, and thus focus site characterization activities and minimize the likelihood that you will collect unnecessary information.

8. Do I have to have a site conceptual model?

Yes. Site conceptual models are needed to ensure thorough and efficient site characterization activities. As discussed in question 7, site conceptual models will improve site characterization processes by providing a common framework from which Volunteers, DEQ, and the public can understand and discuss site information. Site conceptual models show what is known about sites, what is not known, and what information is needed. They organize site information in a way that highlights data gaps, and thus focus site characterization activities and minimize the likelihood that you will collect unnecessary information.

A common criticism of cleanup programs is that individual cleanup actions can stall during the site characterization phase. Site conceptual models will help avoid this by providing a framework for DEQ staff and Volunteers to have fact-based, site-specific discussions (rather than abstract debates) about site characterization activities and by focusing DEQ staff and Volunteers on the information necessary to support cleanup decisions.

Of course, the complexity of site conceptual models should be commensurate with the complexity of the site. Many effective site conceptual models are simply a written description or illustration (such as a table) showing sources, release mechanisms, migration pathways, and potential human and ecological receptors.

Other VRP Fact Sheets and guidance documents to help Volunteers prepare their site conceptual model include: Fact Sheet #11 *Risk Assessment*, Fact Sheet #12 *Soil Cleanup Levels*, and Fact Sheet #14 *Ecological Risk Assessment – Steps 1 and 2*.

9. Do I have to characterize my entire site?

It depends. You may enter the VRP for your entire site, for only a particular area of your site, or a particular set of contaminants, or a particular environmental medium. If you enter the VRP for only a particular area of your site or a particular release, site characterization is needed only for that particular area or release (and any areas affected by that area/release). Please note that any liability assurances issued under the program will be limited to the area or release addressed. If you enter the VRP for your entire site, site characterization should address the entire site.

10. If part of my site has never been used for industrial activities, do I still have to take environmental samples?

It depends. At all sites, DEQ expects that, at a minimum, Volunteers will carry out a thorough investigation of site history and site conditions to identify sources and potential sources (including historical releases) of contaminants. At most sites, this investigation -- and the associated biased sampling that it results in -- will be adequate to meet the site characterization performance criteria and support issuance of a certificate of completion or other VRP liability assurance.

At a few sites, however, grid sampling outside known and suspected areas of contamination may be needed. For instance, at sites where a no further action letter liability assurance is requested, DEQ expects that environmental samples will be collected and grid sampling may be needed outside known or suspected areas of contamination to minimize the likelihood that contamination will be missed.

For more information about liability assurances see the Fact Sheet #15 *Liability Assurances*. Guidelines on grid sampling between known source areas are available in Fact Sheet #9 *Grid Soil Sampling Outside Source Areas*.

11. How are the exact activities necessary for site-specific characterization determined?

Volunteers should use their site conceptual models and work with DEQ to identify the specific site characterization activities necessary to meet the site characterization performance criteria at any given site. Often, the exact activities necessary for site characterization for a given site will be developed in a site-specific site characterization work plan. These work plans generally will be developed by Volunteers and proposed to DEQ for review and approval as part of the process of

negotiating a preliminary remediation agreement for a site. In some cases, negotiation of site characterization work plans will be completed before a preliminary remediation agreement is signed; in other cases, a site characterization work plan might be completed according to a schedule outlined in a preliminary remediation agreement. In still other circumstances (i.e., when a cleanup qualifies for the independent cleanup process (ICP)), no preliminary remediation agreement will be needed.

Site characterization work plans are not necessarily complex or long documents. DEQ's performance-based approach to site characterization, with the required use of site conceptual models (discussed in questions 7 & 8), is designed to ensure that site characterization activities neither delay remedy implementation nor become overly time consuming and expensive. As highlighted by the site characterization performance criteria and DEQ's principles for site characterization, it is very important that Volunteers focus their site characterization activities on gathering the information necessary to support remedial decisions, and tailor their site characterization activities to be appropriate to site-specific conditions and commensurate with the level of complexity presented by a site. There is more information on the content of site-specific site characterization work plans in question 14.

12. Why do I need both a preliminary remediation agreement and a site characterization work plan?

In general, preliminary remediation agreements and site characterization work plans serve different purposes. A preliminary remediation agreement establishes the site-specific procedures, schedules, and objectives for site characterization and (if necessary) evaluations of remedial alternatives. It also establishes a framework within which DEQ and a volunteer can work together to develop a site-specific site characterization work plan. As discussed further in question 14, a site characterization work plan establishes the site-specific activities that are necessary to meet the site characterization performance criteria.

13. How are site characterization work plans developed?

Site characterization work plans generally are developed by Volunteers and reviewed and approved by DEQ. Volunteers should develop their site characterization work plans using all information available about a site; their site conceptual model; the statutory requirements of the VRP; DEQ guidance; and good engineering, geological, and hydrogeological practices. Site characterization work plans should rely on the site conceptual model to identify data needs and gaps.

14. What are the elements of a site characterization work plan?

Site characterization work plans should describe the site conceptual model and describe, with specificity, the activities (e.g., site reconnaissance, collection and analysis of environmental samples) a volunteer plans to carry out to meet the site characterization performance criteria. Additionally, site characterization work plans should describe:

Data quality objectives — that is, the specific purpose of any sampling proposed and how data generated through sampling will be used in a way that contributes to achieving the site characterization performance criteria. (See Fact Sheet #28 *Data Quality Objectives*.)

- Your plan to ensure data quality.
- Sampling and analytical methods. (See Fact Sheet #29 *Sampling and Analysis Plans*.)
- Your plan to protect workers and the public from hazards during site characterization through a site-specific health and safety plan.
- Your plan to document and report site characterization activities.

Additional information on these elements of site characterization work plans is included in Appendix A: Site Characterization Guidelines. As with all other elements of site characterization, the complexity of a volunteer's approach to these elements should be commensurate with the complexity of the site being addressed.

In accordance with §33-41-102, any report or submission containing geologic work that is defined as “practice of geology before the public” must be certified by a Professional Geologist registered in the State of Wyoming.

15. What is DEQ's role in site characterization?

For site characterization, DEQ's role is to provide guidance on developing adequate site characterization work plans, review site characterization work plans, negotiate preliminary remediation agreements, and make decisions about whether site characterization activities meet the site characterization performance criteria. DEQ also will oversee implementation of site characterization activities.

16. Do I have to wait for DEQ to approve my work plan before I begin site characterization activities?

Unless a site is eligible for the ICP, DEQ strongly encourages Volunteers to work with the Department to negotiate a preliminary remediation agreement and a site-specific site characterization work plan before beginning site characterization activities. This up front investment in coordination between Volunteers and DEQ will increase the efficiency of characterization activities by minimizing the need for Volunteers to return to sites to conduct additional characterization activities after DEQ review. If you begin site characterization before DEQ approves your site characterization work plan, you run the risk that your efforts will not be adequate to support selection and implementation of a remedial alternative, and that DEQ will require additional work (including additional sampling and analysis) before making a decision about remediation or about issuance of a liability assurance for your site.

Furthermore, as discussed in response to question 17 below, certain site characterization or cleanup activities may require prior authorization and/or permitting from a variety of city, county, state or federal agencies. When sites are in the VRP, DEQ can work with Volunteers to integrate

approvals (as much as possible) with VRP program approvals, and separate permitting is often not necessary. When sites are not under the VRP, DEQ cannot offer this type of assistance. In addition, of course, permits or authorizations obtained outside the VRP will address only the specific activity being authorized or permitted (i.e., construction of a well). They will not address the adequacy of your site characterization plan or whether you have achieved cleanup standards. To receive DEQ review of your cleanup and to qualify for a certification of completion or other liability assurance, you must enter the VRP.

17. What other requirements apply to site characterization activities?

Site characterization activities may be subject to many other requirements. DEQ has a number of permitting programs that generally apply to common site characterization activities. For example, the construction of a groundwater monitoring well must comply with Water Quality Rules and Regulations and be authorized by DEQ. The Solid Waste Rules and Regulations require permitting before you treat, store, or dispose of a solid or hazardous waste and require compliance with other requirements for solid or hazardous waste accumulation. Similarly, site characterization activities may trigger application of various worker or other health protection requirements, including the requirement to have a site health and safety plan.

DEQ has not attempted to list all potential authorizations and/or permits that might apply to site characterization or cleanup activities in this Fact Sheet. Whether your site is in the VRP or not, you are responsible for determining the programs that may apply to your activities and for obtaining permits or other necessary authorizations. Volunteers who choose to begin site characterization or cleanup before entering the VRP are strongly encouraged to contact the appropriate local, state and federal agencies, including DEQ, to determine if planned activities are regulated.

18. Do I have to wait until site characterization is complete before beginning remedial actions?

No. During site characterization, DEQ expects that Volunteers will evaluate the need for and, as appropriate, design and implement interim remedial actions to control, minimize, or eliminate releases or potential releases of contaminants that pose actual or potential threats to human health or the environment. Volunteers should seek DEQ approval of interim actions prior to implementation unless an immediate action is necessary to abate an imminent and substantial endangerment. To the extent practicable, interim remedial actions should be consistent with the VRP cleanup standards established at §35-11-1605(a).

19. How does site characterization under the VRP relate to Phase I and Phase II environmental site assessment?

The American Society of Testing and Materials (ASTM) have developed standard protocols for Phase I and Phase II environmental site assessments. (See *Standard Guide for Environmental Site Assessments: Phase I Environmental Site Assessment Process* ASTM E 1527-05 and *Standard Guide for Environmental Site Assessments: Phase II Environmental Site Assessment Process*

ASTM E 1903-97.) These protocols are often used to support property transfers both for clean and contaminated property.

Site characterization under the VRP generally will include and build on information gathered during typical Phase I and Phase II environmental site assessments. During a Phase I or preliminary site assessment, information is gathered to identify areas of known or potential environmental contamination. This generally includes reviewing records, interviewing people, and conducting physical inspections of the site, as will often happen during the initial stages of site characterization or as part of developing a site characterization work plan. During a Phase II or confirmatory site assessment, information is gathered to physically confirm the presence or absence of environmental contamination at a site. This generally includes field sampling of environmental media, laboratory analysis of samples, and visual confirmation of environmental contamination at the site, all of which are also elements of site characterization.

Note that completing a Phase I or Phase II environmental site assessment does not guarantee that DEQ will determine that your site has been adequately characterized. Furthermore, property owners will not be eligible for a liability assurance unless they enter the VRP. As discussed earlier in this Fact Sheet, DEQ strongly encourages owners, operators and prospective purchasers of contaminated sites to enter the VRP so they can work with the Department to complete cleanup in a way that will allow them to efficiently qualify for a VRP certificate of completion or other VRP liability assurance.

20. How can I get more information about the VRP?

To learn about VRP sites that may exist in your community, obtain copies of other VRP Fact Sheets/guidance documents, get answers to your questions, or volunteer for the program, contact DEQ at (307) 777-7752 or through the VRP website at: <http://deq.state.wy.us/volremedi/index.asp>.

The VRP website includes all of the Fact Sheets and other guidance documents for the VRP. This website is updated frequently and includes the latest information about DEQ's progress in developing guidance, policy, and other supporting documents for the VRP.

21. References

Standard Guide for Environmental Site Assessments: Phase I Environmental Site Assessment Process. American Society for Testing and Materials (E 1527-05).

Can be purchased at: <http://www.astm.org/cgi-bin/SoftCart.exe/index.shtml?E+mystore>.

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Standard Guide for Environmental Site Assessments: Phase II Environmental Site Assessment Process. American Society for Testing and Materials (E 1903-97; 2002).

Can be purchased at: <http://www.astm.org/cgi-bin/SoftCart.exe/index.shtml?E+mystore>.

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Appendix A: Site Characterization Guidelines

1. *Site characterization performance criteria.* As necessary to develop a conceptual model of the site and the risks and potential risks posed by the site that is adequate and appropriate to support selection and implementation of a permanent or long-term protective remedy that meets the standards in §35-11-1605 for the site and other affected property, site characterization should describe:
 - A. The site and site setting.
 - B. Known and potential sources of contamination.
 - C. The nature and distribution of contaminants and media properties that is likely to influence contaminant distribution or the ability to implement remedial alternatives.
 - D. Human and ecological receptors.

Each of these elements is described more fully below (see #2).

2. *Elements of site characterization.* Site characterization activities should be tailored to the level of complexity of the site and release(s) in question and may be iterative to avoid collection and evaluation of unnecessary information. Documents that may be helpful are listed in the reference section at the end of this document. Site characterization and the site conceptual model should describe the following, as appropriate:
 - A. The site and site setting, including the following, as necessary, to meet the site characterization performance criteria for the area to be included in the remedy agreement:
 - a. The project title, along with the name, address, phone number, and other contact information for the project coordinator.
 - b. Site location including address and legal description.
 - c. Surface and mineral ownership information, including name and address of the current owner, names and addresses of any existing businesses on the site, and names and addresses of any lessees on the site.
 - d. If the applicant is not the property owner, describe the applicant's relationship to the property and the property owner and provide the property owner's name and address.
 - e. A chronological listing of past site owners and operators, including a title search, as appropriate.
 - f. The operational history of the site, including locations and descriptions of all current and historic major processing units, hazardous substance or materials storage units, and waste management units, as appropriate, for the area to be included in the remedy agreement.
 - g. General description of regional geography, geology, and hydrogeology.
 - h. Summary of available information about the contaminants released at or from the site, including:

- i. Type of contaminants.
 - ii. Information on release discovery and subsequent actions taken to investigate, control and remediate the releases and impacted media.
 - iii. Results and conclusions from previous investigations.
 - i. List of all appropriate DEQ permits for the site.
 - j. List of existing groundwater and surface water uses and rights at or within ½ mile of the site.
 - k. A map, or maps, showing relevant site features, such as site boundaries, lease boundaries, easements, adjacent land owners and land uses, surface topography, release areas, surface and subsurface structures, utility lines, and well locations.
 - l. Other pertinent information.
- B. Known and potential sources of contamination (such as tanks, solid waste management units, disposal areas, and releases) including, as necessary to meet the site characterization performance criteria, the following:
- a. Description of all current and historical known and potential sources of contamination and their location at the site. This includes wastes generated at the site that may contain naturally occurring radioactive material (NORM), e.g., heater treater wastes, produced water sludge from oil stock and water tanks, gas dehydrator scale, oil and gas plant processing equipment, etc.
 - b. For releases: date and type of release; size of area affected by release; substances released including identification and concentration of contaminants; description of response actions; and type, construction, and approximate dimensions of unit, if any, involved in release. A release includes, but is not limited to, any sudden spilling, leaking, pumping, pouring, emptying, emitting, discharging, dumping, addition of, escaping, leaching, or unauthorized disposal of any contaminant.
 - c. Other pertinent information.
- C. The nature and distribution of contaminants and media properties that is likely to influence contaminant distribution or the ability to implement remedial alternatives. The following items should be included, as necessary to meet the site characterization performance criteria:
- a. Identification of potentially impacted media. All media listed below should be considered potentially impacted unless it can be shown that the medium is not a concern at the site.
 - i. Soil
 - ii. Groundwater
 - iii. Surface water

- iv. Sediments
- v. Ambient and indoor air
- vi. Vegetation
- b. Identification of contaminants likely to be present based on the conceptual site model. Investigation techniques should be appropriate for the media being investigated and the contaminants that potentially may be present. Cleanup levels for many individual contaminants are presented in the lookup table posted on the DEQ website (see Fact Sheet #12). Note that cleanup levels on the lookup table may have to be adjusted if multiple contaminants are present. Types of contaminants that may be present include:
 - i. Metals
 - ii. Petroleum hydrocarbons and associated contaminants and additives
 - iii. Volatile organic compounds
 - iv. Semivolatile organic compounds
 - v. Polychlorinated biphenyls (PCBs)
 - vi. Pesticides and herbicides
 - vii. Radionuclides
 - viii. Inorganic compounds
- c. Investigation of unconsolidated and consolidated material. If unconsolidated or consolidated material is identified as a potentially impacted medium, surface and subsurface samples should be collected. Sample locations should be appropriate based on the conceptual site model. The number of samples should be sufficient to identify and adequately define the vertical and horizontal extent of contamination. In general, unconsolidated and consolidated material investigations should describe:
 - i. Unconsolidated and consolidated material properties including:
 - (a) Classification of consolidated and unconsolidated material using accepted classification procedures such as Natural Resources Conservation Service (soil) and AGI (bedrock).
 - (b) Description of consolidated and unconsolidated materials including consistency and distribution of unconsolidated material (i.e., alluvium, colluvium, and soil), depth to consolidated material (i.e., bedrock), and characteristics of bedrock and bedrock discontinuities such as faults, fractures, joints, etc.
 - (c) Chemical properties of unconsolidated material (pH, organic content, etc.).
 - (d) Physical properties of unconsolidated material (grain size, distribution, porosity, etc.).
 - ii. Nature and distribution of contamination including:

- (a) Horizontal and vertical extent of contaminants present, including estimated dimensions of contaminated area and volume of contaminated unconsolidated and consolidated material.
 - (b) Specific contaminant concentrations.
 - (c) Site background inorganic contaminant concentrations in unconsolidated and consolidated material.
 - (d) Indications of free product.
 - (e) Contaminant chemical properties and other factors that might affect contaminant migration and transformation.
 - (f) Horizontal and vertical concentration profiles of contaminants.
 - (g) Extrapolation of contaminant movement over time.
 - (h) Evaluation of the potential for contaminant migration into indoor or ambient air based on contaminants present and site conditions.
- d. Investigation of groundwater. If groundwater is identified as a potentially impacted medium, a groundwater investigation should be conducted. The number of groundwater samples should be sufficient to adequately demonstrate that there is no groundwater contamination, or to adequately define the horizontal and vertical extent of contamination. Location of groundwater samples should be appropriate based on the conceptual site model. In general, groundwater investigations, if needed, should describe:
 - i. Hydrogeology, including:
 - (a) Depth to uppermost groundwater.
 - (b) Characterization of uppermost groundwater (including water levels, flow direction and rate, hydraulic conductivity, etc.).
 - (c) Characterization of lower groundwater potentially impacted, as appropriate (including water levels, flow direction rate, hydraulic conductivity, etc.).
 - (d) Regional groundwater flow patterns.
 - (e) Geologic formation(s), lithology, hydraulic connections between saturated zones, porosity, permeability, etc., for each characterized groundwater.
 - (f) Location and extent of impermeable layers, if any.
 - (g) Areas and amounts of groundwater recharge and discharge for each characterized groundwater.
 - (h) Amount and causes of groundwater level fluctuations and flow pattern variations for each characterized groundwater (e.g., seasonal variations, off-site/on-site well pumping).
 - (i) Groundwater classification under Chapter 8 of the Water Quality rules for inorganic contaminants if DEQ has formally classified the Site groundwater.

- (j) Groundwater/surface water interconnections.
 - (k) Other physical and hydrogeochemical characteristics likely to be needed in remedy selection. For example, at sites where monitored natural attenuation may be considered, information appropriate to characterize natural attenuation processes should be collected to support remedy selection.
 - ii. Nature and distribution of contamination, including:
 - (a) Contaminants present and their concentrations and distributions.
 - (b) Configurations of contaminant plumes, for both specific contaminants and totals of related contaminants.
 - (c) Geologic/hydrogeologic controls on contaminant migration/ distributions.
 - (d) Volume of impacted water in contaminant plumes.
 - (e) Proximity of contaminant plumes to property boundaries, wells, and surface water features.
 - (f) Sheen or other indications of free product.
 - (g) Extent and mobility of free product layer, if appropriate.
 - (h) Detectable contamination in public or private drinking water wells.
 - (i) Evaluation of the potential for contaminant migration into indoor or ambient air based on contaminants present and site conditions.
 - (j) For organic compounds that are fairly insoluble in water and are less dense than water (light non-aqueous phase liquids or LNAPLs) or are more dense than water (dense non-aqueous phase liquids or DNAPLs), see references at the end of this document for guidance on monitoring well placement and design.
- e. Investigation of surface water. If surface water is identified as a potentially impacted medium, a surface water investigation should be performed. In general, surface water investigations should include:
 - i. Description and location of potentially impacted ephemeral, intermittent and perennial surface water bodies, including surface water classification.
 - ii. Chemistry of the natural surface water (e.g., pH, TDS, TSS, BOD, alkalinity, conductivity, DO profiles, nutrients, COD, TOC, specific contaminant concentrations).
 - iii. Contaminants present in surface water and their concentrations and distributions.
 - iv. Description of how contaminants entered surface water.
 - v. Rate of contaminant release into surface water.
 - vi. Extent of contaminant plumes.
 - vii. Sheen or other visible indications of contamination.

- f. Investigation of sediments. If sediments under ephemeral, intermittent or perennial surface water are identified as a potentially impacted medium, a sediment investigation should be performed. In general, sediment investigations should include:
 - i. Description and location of potentially impacted sediments.
 - ii. Descriptions of how contaminants entered sediments.
 - iii. Contaminants present in sediments and their concentrations and distributions.
 - iv. Vertical and horizontal extent of contamination.
 - v. Estimated dimensions and volume of contaminated sediment.
 - vi. Concentration of contaminants in pore water, if appropriate.
 - vii. Evaluation of impact of contaminants on biota, based on biological testing, if appropriate.
- g. Investigation of air. If indoor or ambient air is identified as a potentially impacted medium, an air investigation should be performed. In general, air investigations should include:
 - i. Evaluation of impacts of contaminants on indoor air in existing buildings.
 - ii. Estimation of likely impacts of contaminants on indoor air in potential future structures built on the site.
 - iii. Evaluation of impacts of contaminants on ambient air.
 - iv. Information regarding local and regional climatological characteristics which are likely to affect contaminant migration, such as seasonal precipitation patterns, magnitude and frequency of significant storm events, temperature range, prevailing wind directions, and wind velocity.
- h. Investigation of vegetation. If vegetation is identified as a potentially impacted medium, an investigation of vegetation should be performed. In general, vegetation investigations should include, as appropriate:
 - i. Type and level of vegetation use on site (e.g., cow/calf pasture, nesting, waterfowl).
 - ii. List of vegetation species present.
 - iii. Analysis of vegetation samples for accumulation of contaminants.
- D. Human and ecological receptors, including the following, as necessary, to meet the site characterization performance criteria. The human health and ecological checklists used in the VRP address many of the same general topics and may be considered concurrently.
 - a. Number of people who work at or within ¼ mile of the site.
 - b. Number of residents at and within ¼ of the site.
 - c. Sensitive populations present within ¼ mile of the site (e.g., day care facilities and nursing homes).

- d. Number and location of domestic (public and private), industrial, agricultural, and other water supply wells at or within ½ mile of the site.
 - e. Surface water features within ½ mile of the site, including rivers and streams, lakes and ponds, wetlands, and seeps and springs, including seasonal or ephemeral water features.
 - f. Threatened and endangered species habitat at or within ½ mile of the site.
 - g. Cultural resources at or within ½ mile of the site.
 - h. Other pertinent information.
3. *Other topics to be addressed in site characterization work plan.* The data quality objectives process (EPA 1993) is a way to determine the type, quantity, and quality of environmental data needed to support selection and implementation of remedial actions. The data quality objectives are used in planning the site characterization activities. In addition to the information described in Item 1 above, the site characterization work plan should describe the following:
- A. Preliminary cleanup levels. Prior to field activities, conservative preliminary cleanup levels based on unrestricted land use, drinking water standards for groundwater, and ambient water quality criteria for surface water should be identified for all contaminants potentially present at the site. Cleanup levels for groundwater are identified in Fact Sheet #13 *Groundwater Cleanup Levels*. Ambient water quality criteria for surface water are identified in Chapter 1 of the Water Quality Rules & Regulations. Preliminary cleanup levels should be used to determine appropriate laboratory analysis methods and reporting levels. For naturally occurring contaminants, such as metals, radionuclides, and inorganic compounds in soil, groundwater, and surface water, preliminary cleanup levels may be adjusted upward to be equal to the naturally occurring background concentration. Background concentrations for naturally occurring contaminants should be approved by DEQ.
 - B. Sampling methods. All sampling methods should be approved by DEQ before field work is undertaken. If sampling methods are not approved by DEQ in advance of field work, Volunteers run the risk that DEQ may determine that inappropriate or inadequate methods were employed and may require additional sampling.
 - C. Analytical methods. All analytical methods must be appropriate for the contaminants that may be present and the media being investigated. EPA or other standard methods should be used. Laboratory reporting limits should be established at concentrations as low as possible, consistent with DEQ guidance, as outlined in Fact Sheet #29 *Sampling and Analysis Plans*. Contaminants for which commercially available analytical methods cannot achieve reporting limits that are equal to or less than preliminary cleanup levels should be specifically identified in the investigation plan and reports. Information on the Department's approach to groundwater cleanup levels can be found in Fact Sheet #13 *Groundwater Cleanup Levels*. If analytical methods are not approved by DEQ in advance, Volunteers run the risk that DEQ may determine that inappropriate or inadequate methods were employed and may require resampling and additional analysis.

- D. Quality assurance/quality control (QA/QC). All site characterization work plans should include provisions for QA/QC to ensure accuracy, precision, comparability, representativeness, and completeness of the data generated. QA/QC provisions should be consistent with relevant DEQ and EPA guidance.
 - E. Health and safety. All site characterization work plans should be accompanied by a site-specific health and safety plan to protect workers and the public from potential hazards at the site during site characterization activities. Where applicable, site-specific health and safety plans must comply with 29 CFR 1910.120 and with state requirements.
4. *Documentation.* The site owner should submit a site characterization work plan to identify and describe the activities that will be carried out to meet the site characterization performance criteria. Site characterization work plans are subject to review, modification and approval by DEQ. In accordance with §33-41-102, any report or submittal containing geologic work that is defined as “practice of geology before the public” should be certified by a Professional Geologist registered in the State of Wyoming. The site owner should also submit final and progress reports as specified in the site characterization work plan and should maintain all site characterization records, including all raw data, for at least three years after DEQ approval of completion of the remedy for the site.
5. *Interim actions.* During site characterization, the site owner should evaluate the need for, and as appropriate design and implement, interim actions to control, minimize, or eliminate release(s) or potential release(s) of contaminants that pose actual or potential threats to human health and the environment. Except for actions necessary to address an immediate threat to human health or the environment, interim actions may require approval by DEQ prior to implementation. For actions necessary to address an immediate threat, existing notification procedures should be followed. To the extent practicable, interim measures should be consistent with the VRP cleanup standards established by § 35-11-1605(a).
6. *References.* It is intended that the procedures followed for site characterizations under the VRP be consistent with those required by DEQ for site characterization activities under other programs. The following references can be used as guidance for preparing the site characterization work plan.

Data Quality Objectives Process for Superfund, Interim Final Guidance, USEPA, OSWER Publication 9355.9-01, EPA 540 R-93-071, September 1993.

RCRA Corrective Action Plan, USEPA, EPA 520 R-94-004, May 1994.

RCRA Facility Investigation (RFI) Guidance, Interim Final, USEPA, OSWER Directive 9502.00-6D, EPA 530-SW-89-031, May 1989.

Soil Screening Guidance: User's Guide, USEPA, OSWER Publication 9355.4-23, EPA 540-R-96-018, April 1996.

Subpart S ANPRM (Advanced Notice of Proposed Rulemaking), 61 FR 19431, May 1, 1996.

Subpart S proposed rules, 55 FR 30798, July 27, 1990.

Technical Enforcement Guidance Document (TEGD), USEPA, Draft EPA 530-R-93-001, 1993.

Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, USEPA, OSWER Directive 9200.4-17P, April 1999.

Guidance for the Data Quality Objectives Process, EPA QA/G-4, EPA 600-R-96-055, August 2000.

Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HWFfinal, EPA 600-R-00-007, January 2000.

Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency. (Docket ID No. RCRA-2002-0033 November 2002). May be downloaded at <http://www.epa.gov/epawaste/hazard/correctiveaction/eis/vapor.htm>